

Abstract of the Disclosure

The density of at least one fluid in a pipe 12 is determined using a pair of effective sound speeds $a_{1\text{eff}}$ and $a_{2\text{eff}}$ of the fluid/pipe system. The pair of effective system sound speed measurements are taken at two sensing regions X_1 , X_2 along the pipe wherein each of the sensing regions comprises a different system cross sectional compliance. The pair of effective system sound speeds $a_{1\text{eff}}$ and $a_{2\text{eff}}$ are provided to signal processing logic 60, which determines the density of the fluid 13 flowing in the pipe 12. The effective system sound speeds $a_{1\text{eff}}$ and $a_{2\text{eff}}$ may be provided by a pair of sound speed meters positioned at sensing regions X_1 , X_2 wherein the sound speed meters utilize a spatial array of acoustic pressure sensors placed at predetermined axial locations along the pipe 12. The acoustic pressure sensors provide acoustic pressure signals which are utilized to determine the effective system speed of sound $a_{1\text{eff}}$ and $a_{2\text{eff}}$ of the fluid (or mixture)/pipe system. One technique uses acoustic spatial array signal processing techniques with the direction of propagation of the acoustic signals along the longitudinal axis of the pipe 12. However, numerous spatial array-processing techniques may be employed to determine the effective system speed of sounds $a_{1\text{eff}}$ and $a_{2\text{eff}}$. The effective system sound speeds $a_{1\text{eff}}$ and $a_{2\text{eff}}$ measured utilize one-dimensional planar acoustic waves that are lower in frequency (and longer wavelength) signals than those used for ultrasonic flow meters, and thus incorporates pipe compliance with fluid compliance and further is more tolerant to inhomogeneities in the flow. In addition, no external source is required and thus may operate using passive listening. The invention will work with arbitrary sound speed meter spacing and with as few as two sound speed meters.